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Galvanized Roofing:

Its Selection, Application, and Maintenance

By

G. R. Shier

Agricultural Extension Engineer
Department of Agricultural Engineering
Ohio State University

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Contents

Extension Bulletin 216, "Galvanized Roofing: Its Selection, Application, and Maintenance"
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By G. R. SHIER[1]

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GALVANIZED steel sheets have been and will probably continue to be one of the most important roofing materials used on Ohio farm buildings. However, despite its widespread use and popularity, galvanized roofing is little understood, and often gives poor service compared with that which could be obtained if it were properly selected, applied, and maintained.

This bulletin gives general information on the use of galvanized sheets. Many manufacturers, through local dealers, supply additional information useful when using that manufacturer's product.

Wood shingles have good insulation values, are durable when well laid, and are low in maintenance costs. Natural and asbestos slate are durable and fire resistant. Such materials will continue to be used.[2] They have some advantages over galvanized roofing and should be considered when planning to reroof or to construct a new building.

IMPORTANCE OF GALVANIZED ROOFING

The widespread use of galvanized roofing is indicated by a survey made in 1940.[3] The kind of roofing material used on farm buildings was observed in eleven areas scattered over a wide section of the state. The percentage of various materials noted was as follows:

Metal roofing	47.0 per cent
Slate shingles	18.4 " "
Wood shingles	16.6 " "
Asphalt shingles	8.4 " "
Asphalt roll	8.5 " "
Asbestos shingles	1.0 " "

This survey indicates that metal roofing is the most important roofing material used in Ohio. In some areas, as much as 70 per cent of the farm building roofs were metal.

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[1] The author wishes to express appreciation for help given by Prof. R. C. Miller in preparing the material used in this publication.

[2] See Farmers' Bulletin No. 1751, "Roof Coverings for Farm Buildings and Their Repair," for more information on various types of roofing materials.

[3] Chas. Matthews and G. R. Shier—unpublished data.

Why Metal is Used

Galvanized roofs are favored because they:

1. Are durable.
2. Are low in upkeep when properly selected.
3. Are fire resistant.
4. Can be used on flat pitches.
5. Can be used on light-weight roof framing.
6. Save labor in laying.
7. Can be placed over other types of worn-out roofing.
8. Can be walked on without damage to roof.
9. Can be grounded for lightning protection.

Objections to Metal Roofing

Many people, including some of those who are using galvanized roofing, object to it on a number of counts. Among these are:

1. Appearance.
2. Tendency to leak because of improper application.
3. High temperatures under galvanized roofing.
4. Condensation or sweating under galvanized roofs.
5. Noise during wind and rain.
6. The need for frequent application of paint to prevent rust, on the grades of galvanized roofing which have been generally used.

Selection of Galvanized Roofing

Durability

The length of life of galvanized roofing is largely dependent upon the proper construction and maintenance of the roof rather than upon the material itself. However, a heavy weight roof, such as 26-gauge, is less subject to accidental damage and should give longer service, although the lighter gauges give good service when properly laid.

Alloy steels[1] are probably less subject to corrosion than the common grades of steel used in roofing. But, if the roof is to be kept painted after the galvanizing is worn off, there is little advantage in using alloy steels for roofing. For ordinary purposes a heavy weight of zinc galvanizing[2] seems more important than a steel containing copper.

Low Maintenance Cost

Maintenance costs can partially be controlled when selecting the roof. Galvanized roofs do not rust until the zinc galvanizing is worn off. Examples of galvanized roofs which have not shown signs of rust in 40 or more years of use have been found.

[1] Alloy steels contain small amounts of other metals, among which, copper and molybdenum are commonly used.

[2] The Production and use of Galvanized Roofing Sheets, G. C. Bartells and K. J. T. Ekblow, Agricultural Engineering, Vol. 13, No. 2, page 47—Feb., 1932.

Long life for the zinc galvanizing is primarily a matter of getting a roof with sufficient zinc on it. The amount of zinc used in galvanizing can be controlled, and most manufacturers produce more than one weight of zinc coating. The industry has set up a standard of 2 ounces of zinc coating per square foot of roofing as a measure of good quality galvanized sheets. Most of the sheets manufactured of this grade are stamped with a 2-ounce label. Such a label is the buyer's best protection in purchasing good quality sheets. In ordinary farm use, 2-ounce sheets should give from 20 to 30 years of roofing service before rusting becomes noticeable.

Tightness of Roof

Any roofing material will leak when applied improperly. Most of the various types of galvanized roofs sold will be tight if properly laid (see page 8).

Types of Galvanized Roofing

There are five general types of galvanized roofs. These are standing seam, corrugated, V-crimp, flat seam, and shingles. Of these, the first three are of major importance in Ohio. The survey previously mentioned indicated that more than half of the present metal roofs on farm buildings were standing seam. About a fourth were corrugated, and a sixth were of the V-crimp type. Flat seam roofs were not included in the survey. A very few roofs covered with metal shingles were noted.

Standing Seam.—There are several types of standing seam roof, but its essential feature is an upright seam which is doubled over to make it tight. In the best standing seam roofs, the seam is doubled over twice and is known as the double standing seam. The roofing comes either as a roll to be crimped on the job or occasionally as sheets which have been partly pressed into shape at the mill. All roofing of this type requires special tools and more than average skill to lay. The roof is fastened down by means of clips which emerge through the seam before it is doubled over. This avoids the need for nails through the roofing and makes it possible to build a very tight roof.

If standing seam is laid on slopes flatter than 6 inches per foot, it should be the double seam type and the work should be carefully done to insure tightness. On slopes of 3 inches or less per foot, standing seam should never be laid on sheds attached to other buildings unless eave troughs are used to prevent water from the upper roof falling on the shed roof (see Figure 1). On flat slopes of less than 3 inches per foot standing seam should be used only on short roofs of 12 feet or less. Usually, it is much better to use the flat seam soldered roofing for short flat slopes.

Standing seam roofing material has not been generally available in the heavier zinc coating, such as the 2-ounce zinc coated steel. Because of the light zinc coating, rust soon appears. It is usually necessary to paint within 3 to 5 years to prevent rusting, although some cases have been observed where this type of roofing was laid with heavily galvanized material which

lasted many years with very little rusting. Standing seam should be laid over tight sheathing so that wind pressure cannot get under the metal and cause noise and eventual damage to the roof.

Corrugated Sheets.—This type is made in several widths of corrugations, 1¼-inch and 2½-inch being most common. It is available in 2-ounce coated sheets in 26 and 28 gauge. The heavier gauges are most desirable and 29 gauge is unsuited except when laid over tight sheathing. The 2½-inch corrugated roofing has greater water carrying capacity and is adapted to long roof slopes. Because 26 and 28 gauge corrugated sheets are stiff they can be laid over slatted decks. They are easy to lay and when properly nailed should give excellent service.

The 1¼-inch sheets are 26 inches wide and cover 24 inches net width of roof. The 2½-inch sheets are 27½ inches wide and cover 24 inches net width of roof. Corrugated sheets are lapped 1½ corrugations on the sides which accounts for the wider lap of the 2½-inch sheets. Corrugated roofing

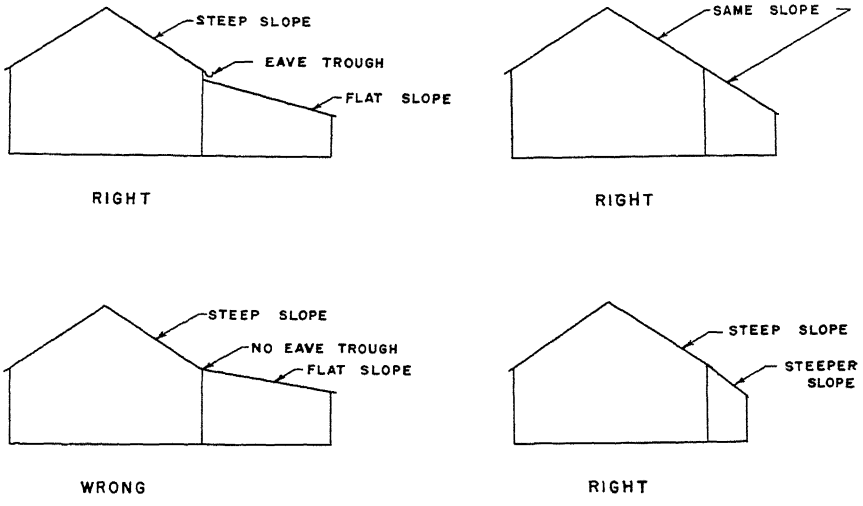

Fig. 1.—This figure illustrates method of adding shed roof to larger buildings so as to prevent leaks. The diagram at lower left shows the wrong method of connecting the shed roof to the main building.

sheets should have one edge turned up and one down in order to lap properly.

The 2½-inch sheets are also available in a 26-inch width with both edges turned the same direction. These sheets are intended for use on sidewalls or interiors were less lap is sometimes used, and should never be used for roofing (see page 8 for roof slopes).

V-Crimp.—This type is made with from two to six crimps running the length of the sheet. Of these, the five-crimp and six-crimp are much the best for roofing purposes, as they have tight laps and are more rigid than the sheets with fewer crimps. V-crimps come in 26, 28 and 29 gauge sheets, and can be obtained with 2-ounce coatings of zinc galvanizing in 26 and 28 gauge.

V-crimp should be used only over tight sheathing. If used over open slats, it is noisy and may be subject to damage by wind or from the weight of man or snow. V-crimp sheets are cut to cover 24 inches net width of roof. Three-sided wood strips are used under the side laps to provide a firm nailing support.

The strips should be obtained from the manufacturer of the sheets used, as there is some variation in the shape and size of the crimps from different sources (see page 8 for roof slopes).

Special Crimps and Drains.—Most manufacturers make several types of sheets which usually are a variation of the V-crimp type of sheet. Some of these special crimps which are known under various trade names can be had in the heavy 2-ounce coats of zinc galvanizing. These special sheets usually have a special drainage channel in the side lap which is intended to carry away water in case it should leak through the lap joint.

Because these special sheets have the same general physical characteristics of V-crimp roofing, they are suitable for the same uses as V-crimp, except that some of them cannot be used safely on slopes of less than quarter pitch (a slope of 6 inches per foot). From the standpoint of tightness and strength they generally have no advantage over V-crimp and corrugated sheets.

Flat-Seam Roofing.—This type of roofing is made up from sheets of galvanized or tinned steel. The joints are soldered and fastened to the sheathing by clips as they are put in place. Flat seam roofing can be used on very flat surfaces as there are no possible places for leaks if the soldering is carefully done.

Special equipment and skill is required to lay flat-seam roofing. Solid sheathing should always be used under flat-seam roofing. In most cases the use of flat-seam roofing is confined to comparatively small porch or dormer roof decks. When properly laid and kept painted, it makes a durable watertight roof.

Application of Galvanized Roofing[1]

Avoid Damaged Sheets

Strange as it may seem, bundles of galvanized sheets are often seriously damaged by allowing them to get wet from rain or dew. When the closely packed sheets get moisture between them in the absence of air, they rapidly corrode, forming a thick white substance. A few hours of exposure to rain or dew may cause the corrsion of nearly all the zinc coating. Damaged sheets must be brushed, cleaned, and painted immediately to protect the steel from rusting.

In order to avoid damage from this type of corrosion, the bundles of sheets should be kept dry. If it is necessary to keep them outdoors, stand them up on end and loosen the bundles so that air can circulate between the

[1] The author is indebted to the American Zinc Institute, the manufacturers of galvanized steel roofing, and the United States Dept. of Agriculture for many of the suggestions in this section.

sheets. When sheets are purchased, they should be inspected for damage and all damaged sheets rejected.

Metal May be Used on Low Pitched Roofs

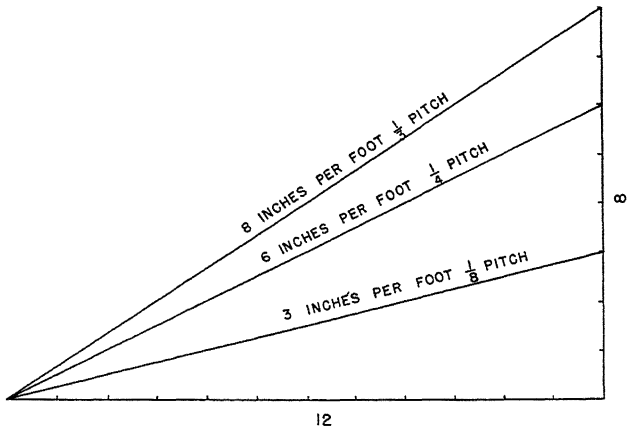

Fig. 2.—The pitch of a roof is very important in determining whether it will leak or not. Pitches, commonly used, are shown above.

Figure 2 shows roof slopes of 3, 6, and 8 inches per foot. Corrugated, V-crimp, and the special crimps all do best if kept on slopes of 6 inches or more per foot, although on short roofs corrugated and V-crimp may be used on slopes as flat as 3 inches per foot.

The double standing seam is usually satisfactory for slopes as low as 3 inches per foot, and for short roofs may be used as flat as 2 inches per foot. Flat seam roofing can be used on roofs that are flat or nearly so.

Sheds are often attached to larger buildings. Figure 1 illustrates the danger in allowing water from a steep roof to accumulate on a flat roof. *If it is necessary to place a shed below a steep roof, space should be left for an eave trough to collect the water from the steep roof before it falls on the flatter shed roof.* If water is not collected in an eave trough, it will pile up on the shed roof and usually result in leakage except in the case of soldered flat seam roofing.

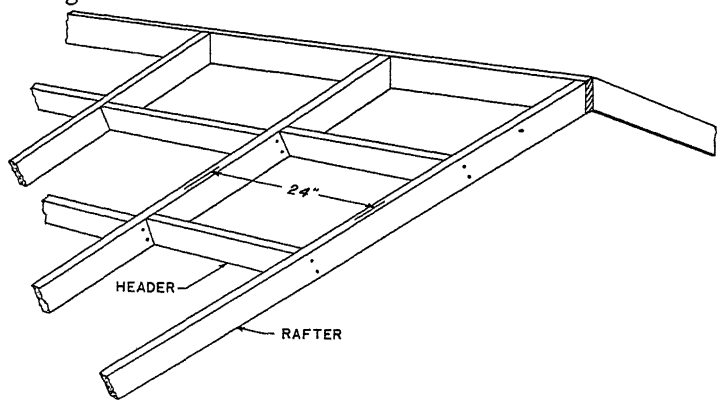

Fig. 3.—The header method of framing for corrugated sheets has excellent nailing surface. Long nails can be used when nailing the roof on. This method of framing is unsuitable, except for corrugated sheets.

Support for Galvanized Roofing

All types of galvanized roofing except corrugated should be laid over tightly sheathed decks. If this is not done, the roof will be noisy and subject to wind damage.

Corrugated sheets can be laid on slats, or on the rafters if headers are provided at suitable intervals.

Headers or slats 24 inches apart are suitable for 26 gauge 2½-inch corrugated. When the headers are spaced 18 inches apart they will adequately support 28 gauge 2½-inch or 26 gauge 1¼-inch corrugated. Support for 28 gauge 1¼-inch corrugated sheets should be supplied every 12 inches. The methods of constructing header or slat framing for corrugated sheets are illustrated in Figures 3 and 4. Support must be provided on the side laps for nailing every 8 inches. If nailing strips are placed more than 8 inches apart, a 1- by 2-inch strip should be nailed on top of the rafters to provide firm support under the side laps as shown in Figure 4.

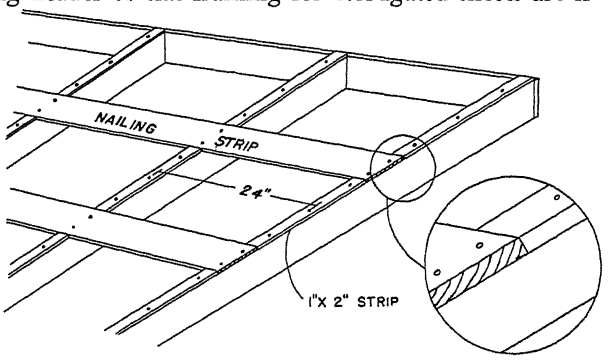

Fig. 4.—Method of attaching nailing strips to rafters. The strips of wood on rafters provide a solid nailing surface for side laps.

Laying the Roof

How to Lay the Sheets.—The first sheet to be laid should start at the lower corner farthest from the direction of the prevailing wind, so that the

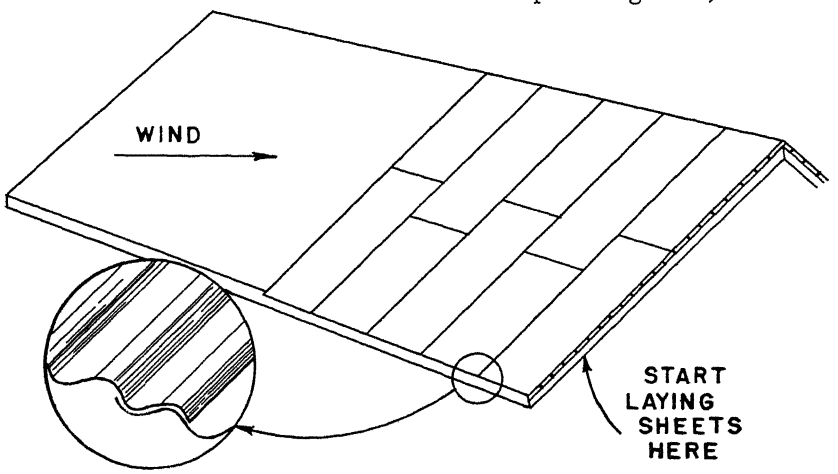

Fig. 5.—All types of roofing sheets should be laid so that the open edge of the lap is away from the prevailing winds, otherwise heavy winds may blow rain under the lap, particularly on flat roofs.

tendency of the wind will be to blow over the lap rather than under it (see Figure 5).

General practice is to lay the roofing from the eave to the ridge, then returning to the eave to start another section of sheets. However, corrugated sheets may be laid crosswise rather than up to the eave if that mehod saves labor.

Nailing the Sheets.—Proper nailing with the best quality nails is most important. Figure 6 shows several types of nails used. *All nails used should be hot-dipped galvanized.* Of these various types, Nail G, the screw type shown to the right in Figure 6, has greater holding power[1] and is more desirable. The nail should have a broad steel head with a lead washer under it for greater strength and durability. The solid lead headed nails are unsatisfactory as they lose their heads too easily for ordinary use with galvanized roofing.

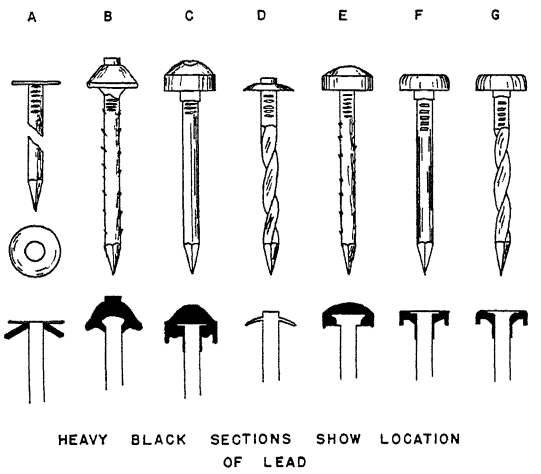

Fig. 6.—Types of nails which are commonly sold for nailing galvanized roofing sheets. The nail shown under "G" is by far the most satisfactory.

The nails should penetrate into the nailing strips, rafters, or headers at least an inch. Roofing nails are available in lengths up to 2½ inches.

The long nails are very desirable for corrugated sheets laid over open framing, and should be used when nailing into 2-inch headers or rafters.

Lead-headed nails are not necessary for standing seam or flat-seam roofing, but a screw type is desirable. Nail D, in Figure 6, is used on sidewalls.

When nailing over old roofs such as wood shingles or asphalt composition, or roofs where the rafters and nailing strips are spaced irregularly, it is best to lay new nailing strips over the old roof before applying the galvanized roofing. The new nailing strips should be carefully nailed with 16-penny nails to the rafters. The strips should be spaced so that the side laps of the sheets can be nailed every 8 inches. Strips of 1- by 4-inch material, spaced 8 inches on center, are suitable. Rough sawed native hardwoods cut a full inch make excellent nailing strips.

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[1] Agricultural Engineering, Vol. 17, No. 7, page 295, July, 1936. According to data presented for tests of certain screw shank nails, they had six times the holding power of barbed nails, and 10 times the holding power of smooth nails after 76 days' exposure to weather. The Wood Hand Book, published by the United States Department of Agriculture Forest Service, states that screw type nail shanks retain a large percentage of their holding power when driven into green wood.

Fastening the End Laps.—Corrugated sheets are nailed every 5 inches across the ends (every second ridge for 2½-inch sheets and every fourth ridge for 1¼-inch sheets). A lap of 6 inches is usually allowed at the ends of corrugated, V-crimp, and special roofing sheets. On slopes of less than 6 inches per foot, 8- to 12-inch end laps are desirable. Because the corrugated can be nailed frequently across the ends, they fit down very snugly. The V-crimp types, with only one or no corrugations down the center of the sheet, cannot be nailed so tightly.

V-crimp roofing is also applied with locked end joint seams. A pair of tinner's snips and flanging tongs are necessary for this type joint.

Valleys, Flashings, etc.—Specially formed shapes are available for nearly all the types and forms of galvanized roofing to be used as flashings, valleys, ridges, and joints. These special fittings save much labor and reduce the danger of leakage. Their use is suggested rather than attempting to form the necessary fittings from flat sheets.

Laying Standing Seam.—Standing seam roofing should be laid over tight sheathing to give it solid support. It usually must be laid by a tinner or roofer who has the special tools needed to bend the seams into shape. The finished seams should be about 1 inch high after they have been doubled over twice. The roof is held down by cleats which emerge between the seams. When the seams are bent over, the cleats are bent with the seam. When the seam is finished, the cleats are invisible.

In order to secure the roof safely to the building, the cleats should be spaced 8 to 12 inches apart along the seams and nailed down with 1-inch galvanized screw type roofing nails similar to the nail G in Figure 6, except that the lead washer is omitted.

Use of Paper Under Galvanized Roofing.—Paper laid under a galvanized roof helps to deaden the noise during rain and wind. A 14- or 16-pound asbestos felt is suggested for this purpose. Tar papers should be avoided, as the heat of the roof on bright days increases the activity of the acid often found in the tar, and hastens corrosion on the under side of the metal roofing. No harm has been observed when galvanized roofing has been laid over old, weathered, slate surfaced composition roofs.

To Prevent Sweating under Galvanized Roofs

Galvanized roofs transmit heat readily and, as a result, condensation or "sweating" frequently occurs on the under side of the roof. The sweating is caused when warm damp air comes in contact with the cold metal. The use of solid sheathing under the metal prevents sweating in many cases, but in dairy barns, hog houses, and poultry houses, moisture conditions are severe. If there is a loft above the animal quarters, all openings to the loft should be kept closed to prevent accumulation of warm damp air under the roof.[1]

[1] For information on control of temperature and ventilation in animal buildings obtain a copy of Extension Bulletin No. 208 from your local county Agricultural Extension Office.

Sweating may also occur under a roof in a poorly ventilated building containing some source of moisture, or when a cold rain from a sudden thunder-shower falls on the building after warm bright weather. This type sweating can be controlled by sheathing under the roof, or under the rafters, by better ventilation, or by removal of the source of the moisture.

Many poorly built metal roofs appear to sweat during rain storms. Close inspection will determine whether the moisture is due to leaks or "sweating." Leaks are usually due to improper laying of the metal roof and may be difficult to correct, unless the roof is relaid, observing proper precautions.

Insulation of Metal Roofs[1]

Metal roofs can be insulated. For most buildings, except possibly refrigerated storages, the inner side of the insulation must be protected with some vaporproofing material such as an asphalt coated paper, a metal clad paper, metal sheathing, or in some cases the use of two or three coats of aluminum paint.

Common Faults in Applying Metal Roofing

1. Failure to provide solid sheathing under all types except corrugated sheets.
2. Failure to nail the side laps at 8-inch intervals with a suitable nail such as the screw type shown under G in Figure 6.
3. The use of galvanized roofing on a long flat, shed roof below a steep barn roof (see Figure 1).
4. Failure to provide support under the side laps when nailing corrugated sheets over slats (see Figure 4).
5. Failure to allow 8 to 12 inches end lap for slopes less than 6 inches per foot.
6. Driving nails in the valleys.

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Metal Roofs and Lightning Protection[2]

The usefulness of metal roofing in protecting buildings against lightning seems to be little recognized in Ohio. Although lightning rods are unnecessary on metal roofed buildings when the roof is properly grounded, many Ohio barns have lightning rods above metal roofs, and it is not at all uncommon to see new metal roofed barns topped by a new set of lightning rods.

The following quotation is taken from the "Code for Protection against Lightning"[3] by the American Standards Association.

[1] A complete discussion of insulation for animal buildings will be found in Extension Bulletin 208, available from Ohio county Agricultural Extension Agents.

[2] Farmers' Bulletin No. 1512, "Protection of Buildings and Farm Property from Lightning" gives additional information on lightning protection.

[3] Miscellaneous Publication No. 92 of the Bureau of Standards. It can be obtained from the Superintendent of Documents, Washington, D. C., at a cost of 25 cents cash.

"(a) *Metal in Overlapping Sections.*—Buildings which are roofed, or roofed and clad with metal in the form of sections insulated from one another, or so applied that they are not in metallic contact, shall be treated in the same manner as are buildings composed of nonconducting materials.

"(b) *Metal Continuous.*—When buildings are roofed, or roofed and clad with all-metal sheets made electrically continuous by means of an interlocking or other contact, or by bonding, the following modifications may be made.

"Air terminals need be provided only on chimneys, ventilators, gables, and other projections, such as are likely to receive and be damaged by a stroke of lightning. Projections that are likely to receive, but not be damaged by, a stroke of lightning need not be provided with air terminals but shall be securely bonded to the roof.

"Roof conductors may be dispensed with and elevation rods, if used, connected to the roof by soldered joints, or securely bolted joints, having an area of contact of not less than 3 square inches * * * * : If the roof metal is in small sections, connection shall be made to at least four of the sections.

"Down conductors shall be connected to the edges of roofs, or to the lower edges of metal siding, by soldered or bolted joints having an area of at least 3 square inches * * * * . If the metal is in small sections, connection shall be made to at least four of the sections."

MAKING GROUND CONNECTIONS

When grounding metal roofed buildings, it is only necessary to attach the roof securely to suitable ground connections at two or more places, usually diagonally opposite corners. If the building has a wing, the wing should also be grounded.

Figure 7 illustrates the method of attaching a pipe ground to the roof in accordance with the code given above.

Figure 8 shows how the ground should be set into the earth. Moist earth is better than dry earth for grounding lightning.

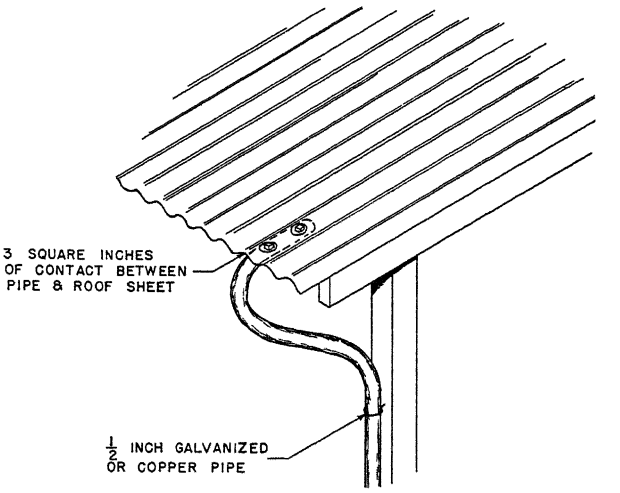

FIG. 7.—Galvanized or copper pipes can be used to ground metal roofs, but should be attached as shown above.

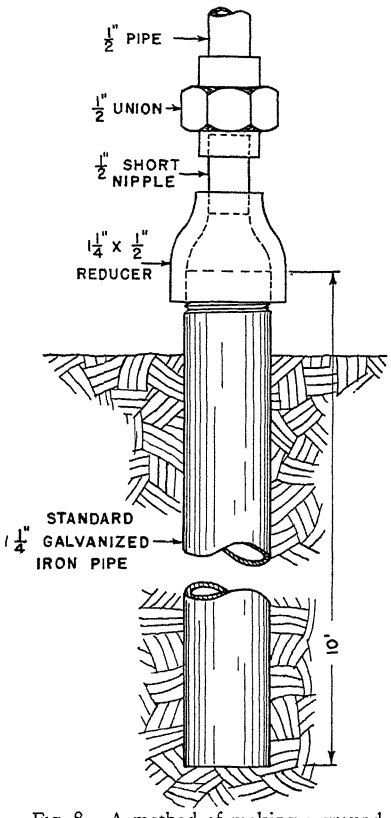

Fig. 8.—A method of making a ground connection for galvanized roofs.

Galvanized Pipe for Ground

The ground can be constructed of galvanized pipe as illustrated in Figures 7 and 8. The pipe will need to be renewed every few years because it will slowly corrode and lose its effectiveness. Copper pipe can be used in place of galvanized pipe at little extra expense, and will last for many years.

In many kinds of soil, galvanized pipe can be easily driven to a depth of 10 feet. A soil auger or a posthole digger can be used to make a hole for copper pipe. If the soil is too rocky for driving or drilling, it will be necessary to dig with a spade.

Where bed rock is near the surface, the ground pipe can be laid horizontally in a trench to secure a better ground contact. Another method sometimes used is to increase the number of ground connections to the roof if the soil is too shallow to obtain two deep ground connections.

Excerpts from the "Code for Protection against Lightning," as related to the installation of down conductors, are given on page 13.

Other Uses for Galvanized Sheets

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Exterior and Interior Sidewalls

Galvanized roof sheets are suitable for use on exterior sidewalls of such buildings as open sheds, garages, machine sheds, shops, and similar buildings where the interior of the building is generally dry with no important source of moisture to cause condensation or "sweating."

In dairy barns, poultry houses, and other livestock buildings, galvanized sheets may be used on the inside of the walls to protect insulation material from the moisture within the building. If galvanized metal is used on the inside, it can also be used on the outside provided ventilation is provided at the top of the wall for the insulation material. If metal is used on the outside of the wall, the joints on the inside of the wall should be sealed to prevent moisture escaping through the cracks into insulation material in the wall where it might be trapped between the two layers of metal.

Sealing the Joints

The manufacturers[1] of steel roofing recommend an inexpensive paste composed of 8 pounds of Venetian red and 1 quart of raw linseed oil to be used to seal the joints. It should be applied to the exposed edge of the sheet as the sheets are placed on the wall and immediately covered with the next sheet and securely nailed down.

Tar or caulking compounds containing tar should be avoided, as they frequently contain acids that damage the sheets.

Corrugated Sheets on Exterior Walls

The walls of farm buildings are subject to bumps from farm machines and animals. The 26-gauge 2½-inch corrugated sheet has more structural strength than most other types of sheets and is likely to escape damage more easily than V-crimp types when exposed on outside walls. It is also stiff enough so that sheathing is not necessary to give support on such buildings as garages and machine sheds. Flat sheets often wrinkle when applied to wood frame walls due to expansion and contraction of the walls caused by changes in temperature of the sheets and changes in moisture content in the wood framing.

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Paints for Galvanized Roofing[2]

In many localities, most of the roofing on farm buildings is galvanized iron. Many of the roofs carry a minimum of zinc galvanizing. Lightweight galvanizing usually shows rust in a few years, making it necessary to paint to secure good appearance and to prevent serious damage from rust. Better quality galvanizing, lasting from 20 to 30 years, can be had at slight extra cost. The buyer can identify good quality sheets furnished by most manufacturers by the 2-ounce label stamped on each sheet.

Galvanized iron is somewhat difficult to paint, but good results can be secured if the painting is properly done, using good materials.

Aluminum Paint

The use of aluminum paint on rusted or partially rusted roofs should be confined to second or third coats. The first coat should be a rust-preventing paint, such as blue lead or metallic zinc dust which are discussed on pages 17 and 18.

The chief merit of aluminum paint for metal roofs is its ability to reflect a substantial portion of the light which falls upon it. Dark painted roofs heat up to much higher temperatures than aluminum painted roofs.

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[1] National Association of Flat Rolled Steel Manufacturers, Pittsburgh, Pennsylvania.

[2] Among sources of information used are: Farmers' Bulletin 1452, "Painting on the Farm"; Iowa Extension Circular 732, "Selecting and Applying Paints," *Agricultural Engineering*, March, 1939; and handbooks published by the manufacturers of paint materials.

According to tests[1] in California, aluminum paint on galvanized iron roofing laid over a framework similar to that shown in Figure 4, made temperatures under the roof as cool as if unpainted galvanized iron had been laid over a tight roof such as shiplap would make. A good coat of aluminum paint apparently was about equal to ½ inch of insulation board placed directly under the roofing.

Aluminum paint applied directly as a single coat to rusty iron roofs usually begins to discolor and fail in the second year. When applied over good grades of metallic zinc or blue lead paints, aluminum can be expected to give several years of satisfactory service.

Aluminum paint weighs about 8 pounds per gallon and usually contains from 1¾ to 2 pounds of aluminum powder per gallon of oil. Quick-drying types of oils are used.

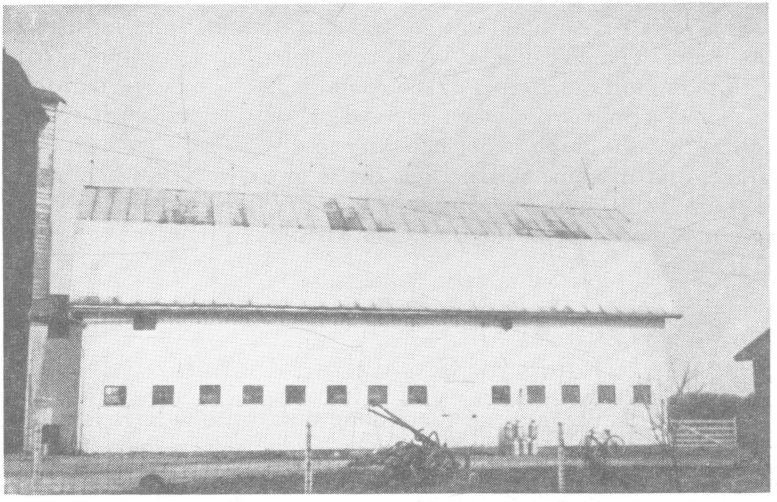

Fig. 9.—The roof on this barn was painted (on the side shown in the picture) with a good grade of aluminum paint. The picture shows the roof after about 1½ years of service. Note that the rust is showing through the aluminum paint. Rapid rusting under aluminum paint is generally characteristic of aluminum paints applied over rusty iron. Fig. 10 shows the other side of this roof.

Black Paints

There are several types of black paints commonly used. These usually contain graphite, carbon black, tar, or asphalt with various types of fillers such as asbestos, chalk, or silicates. None of these paints give very long service when used as single coats. A more durable black paint often used industrially is made from a mixture of red lead, carbon black, and Prussian blue. This mixture is generally applied as a second or even a third coat over a priming coat of red lead.

In addition to short life as single coats, black paints are undesirable on roofs because they absorb most of the sunlight, turning it into heat.

Tar and asphalt are inexpensive, but they often contain acids which hasten damage to metal roofs. Roofs which have been painted black can be repainted

[1] "Flow of Heat Through Roofs," *Agricultural Engineering*, June, 1939.

with a rust resistant paint, but it is essential that all the old black paint be removed with a paint remover, or allowed to weather away.

Blue Lead

Blue lead is sold as a prime coat to be covered with finish coats of aluminum, green, or black. It is fairly rust resistant and slightly less expensive than red lead. It also weighs less per gallon. When used as a single coat, it fades and chalks away more rapidly than metallic zinc dust paints.

Blue lead has been used on metal barn roofs mostly as a primer under aluminum where it has given fairly good results. It is poisonous and should not be used if water from the roof is used for animal or human consumption.

Fig. 10.—This is the opposite side of the barn shown in Fig. 9. The roof on this side was painted with a good grade of metallic zinc paint at the time when the aluminum paint was applied to the roof on the other side. No rusting is apparent now, although this side of the barn was rusted as badly as the side painted with aluminum. A single coat of metallic zinc paint should hold a rusty surface in check for five or six years, and give a fairly good appearance for even longer.

Green Paints

Satisfactory green paints seem to be difficult to obtain. Paints containing chrome green usually fade in the sunlight. Chromium oxide paints hold color better. Green paints give the best service when applied over rust-preventing primers. Blue lead and metallic zinc dust paints have given fairly good results as primers. A mixture of metallic zinc dust and chrome oxide is sold as a single-coat application. It has not been used extensively as yet, but for single-coat applications on rusted roofs it seems likely to be more durable than other green paints generally available.

Iron Oxide Paint

There are several iron oxide pigments commonly used. They are listed in formulas under various names such as Venetian red, vermillion, metallic oxide, or Indian red. Indian red is almost pure iron oxide, but Venetian red contains

a large proportion of such fillers as chalk or silicates. Good iron oxide paints weigh from 13 to 14 pounds per gallon. Iron oxide paints should contain about 30 per cent pure iron oxide; the rest of the pigment being mostly silicates in the better quality paints.

Iron oxide paints are the red paints commonly seen on metal roofs. A good grade of iron oxide paint properly applied makes an inexpensive and fairly durable coating either in single-or two-coat applications. It is non-poisonous and therefore suitable for roofs used to collect water for cisterns or reservoirs.

Metallic Zinc Dust Paints

Good quality metallic zinc dust paint is a battleship gray in color. It is the most durable paint for old rusty galvanized roofs. Single-coat applications can usually be depended upon for five years or more. Two-coat work gives much longer service. It can be used both as a primer and as finish coat.

The best quality formula contains 80 per cent metallic zinc dust and 20 per cent zinc oxide in linseed oil. Cheaper grades contain less zinc dust and are not as durable as the 80-per cent formula.

Zinc dust paints can be tinted. A durable red paint is made by the addition of a good grade iron oxide such as Indian red. Chromium oxide is also mixed with zinc dust to get a green. It is less durable than the straight zinc dust, zinc oxide formula, or the mixture of zinc dust and iron oxide.

None of the zinc dust paints require prime coats, thus making it possible to use them as single-coat applications, although on badly rusted spots two coats are always desirable.

The best metallic zinc-dust paint weighs about 23 pounds per gallon when purchased ready-mixed.

Red Lead

Red lead has long been used as a primer on structural steel. It is the orange colored paint commonly seen on steel being used in the erection of bridges, steel frame buildings, etc.

Red lead has desirable rust preventing properties, but does not weather very well when used alone as a finish coat. When used as a finish coat, it is usually tinted with carbon black to make a brown paint, or with carbon black and Prussian blue to make a black.

The best ready-mixed, red lead paint weighs about 28 pounds per gallon, but when tinted to a brown may weigh about 25 pounds per gallon and when made up as a black paint about 11½ pounds per gallon. Red lead is poisonous, and should not be used on roofs if the water is saved for animal or human consumption.

Paint Materials

Linseed Oil.—Raw linseed oil is commonly used in all good paints. Substitutes such as paint oil or aqueous solutions (water) should not be allowed. Boiled linseed oil is sometimes used to hasten drying.

Soybean Oil.—Raw soybean oil is unsuited for paints because it dries too slowly. When properly refined, it is mixed in some prepared paints and has given good service. The soybean oil content in paints ranges up to 30 per cent of the liquid part of paint and in some paint tests larger amounts of refined soybean oil have given good results.

Driers and Thinners.—Driers and thinners need be no more than 10 per cent of the liquid in such paints as metallic zinc dust, red lead, blue lead, and iron oxide. However, larger amounts are frequently added to hasten the drying of a paint or to thin paints containing varnish. Fast drying paints containing varnish rather than linseed oil may contain 40 per cent or more of thinners and driers.

Dark colored paints containing little or no red lead or zinc oxide dry rather slowly. These paints often contain some varnish, and it becames necessary to add additional thinner and drier to make the varnish workable. Because most driers and all thinners evaporate, they reduce the coverage rate of the paint.

Pure turpentine is the best thinner. Low-grade paints often contain mineral spirits instead of turpentine.

Varnish.—Varnish oils are always used with aluminum paint and to some extent with dark colored paints such as green, red, and black roof paints.

The varnish hastens hardening of the paint but is not necessary or desirable with such paints as metallic zinc dust, iron oxide, red lead, and blue lead unless it is essential to have a quick drying paint.

Varnish or varnish oils do not add to the durability of the latter types of roof paints.

Applying the Paint

Paint Roof When Warm.—In order to get good adherence and good coverage metal should be painted only when it is warm. Paint applied on cool, cloudy days does not spread evenly and does not cover as much roof area. Condensation of moisture often occurs on metal roofing, and it is essential that the roof be painted only after exposure to sufficient sunshine to drive off all moisture.

Clean Roof Before Painting.—Dirt and loose rust should be removed with a wire brush and a dry mop before the paint is applied. Paint does not stick to some types of new galvanized surfaces. Unless the type of metal used is designed for immediate application of paint, the roof should be allowed to weather six months or more before painting. Ordiarily, there is no object in painting galvanized roofs before rust begins to develop, unless a special roof color is desired.

Give Rusty Spots Two Coats.—When rust appears on a galvanized roof, the sheets do not rust uniformly. Variations in manufacturing, exporsure, and treatment often produce rusty patches. It is desirable to clean the roof and apply a coat of paint to the rusty patches before applying a coat of paint over the entire roof. This is particularly true if the rust has penetrated deep enough to form a rough pitted surface. Preliminary coats on the rough spots may add several years to the life of a good paint such as metallic zinc dust.

Preparing Roof for Repainting.—If previous coats of paint have given unsatisfactory service, it will be necessary to remove all traces of the old paint before applying the new coat. Asphalt and tar can be removed with gasoline or benzene. Traces of old oil paints can be removed with some of the water soluble paint removers which soften up the old paint so that it can be removed by scraping, sanding, brushing, or washing with soap and water.

If a water soluble paint remover is used, repainting should be delayed until the roof has been flushed with water and thoroughly dried.